values of these. We may take therefore these values as the characteristics of the different substances. How many of such characteristics exist I cannot tell. Only for simplicity's sake I will assume that two of them are sufficient. As I will take care not to deduce any conclusions from this number, we shall not be led into error by accepting it.

We place these two characteristics in a system of planar coordinates; then the several elements will be represented by single points in the plane. We lay the plane horizontally and raise from these points ordinates, representing the available energy of each element. Between the points of the elements in the plane are situated the points of all possible solutions, filling up the whole plane. Each of these solutions will also have its available energy, and all the corresponding points in space will form a continuous surface. The form of this surface can be described in a general way. For as each *element* has its point in a *relative minimum*, the surface as a whole will have a shape like the ceiling of a cavern full of hanging stalactites, the end of each stalactite representing an element.

How can we pass from one element to another? Evidently not otherwise than by going over the higher parts of the surface, or the passes separating each stalactite from its neighbours. This can only be done by accumulating an appropriate amount of available energy in the element to be changed. Now the concentration of energy is a task we cannot accomplish *ad libitum*, for the possibility very soon ends. Think, for example, of compressing a gas into a given space. Up to some ten thousand atmospheres the work of compression will go on smoothly, but after that every metal begins to flow like a liquid, and you cannot proceed further. With the concentration of electric or any other energy the task is similar, and so we come to the conclusion that the concentration of energy can be pushed to only a very limited extent. The application of this result to our question about elements is simple enough: we cannot get over the pass between two stalactites because we cannot attain the necessary concentration of energy.

From the history of science we learn that these considerations contain at least some truth, for the isolation of the elements has ever been dependent upon the power of concentrating energy available at that time. The most brilliant example is the application of the voltaic pile to the isolation of the alkali metals by Humphry Davy.

Still I must confess that these last considerations are in a very embryonic state, and I should not have brought them before you if an unexpected application had not lately made itself manifest. Some years ago I explained these views to my old friend Sir William Ramsay, when he asked me how the idea of elements fitted into my conceptions of energy. Then I forgot all about it until Sir William reminded me of it, saying that his perplexing discovery of the transmutation of radium into helium might conceivably find some explanation in this way. This I am convinced of, and the considerations may be pictured in the following manner.

In the corner of our cavern where the elements with the highest combining weight are assembled, the stalactites are very short; and at last they are not really stalactites, but rather regions of different slope in the sloping ceiling. Where the plane is nearly horizontal a drop of water furnishes a picture of the stability of the elements. While hanging at the end of a true stalactite, more or less work must be done to raise the drop over the pass until it flows down another stalactite. But in this corner it will flow of its own accord, and only delay for a short time on the nearly horizontal portions in the ceiling.

Such elements will have only a *temporary existence*. Now we are sure that for the transmutation of one element into another enormous amounts of energy would be required, for the concentrations of energy as yet available have proved themselves insufficient for this purpose. We may expect, therefore, that enormous amounts of energy will be liberated if such an unstable element changes into a stable one. This accounts for the extraordinary quantity of energy developed by radium during its existence. The fact that radium changes into helium, an element with an exceptionally long stalactite (for it is impossible to get even any combination of helium), makes us expect indeed such an unusually great development of energy as is found to occur.[1]

The heat from radium is surely only the last form of the energy developed in its transformation. There are a great many intermediate forms, termed rays or radiations, which have been studied by a band of eminent workers, whose ingenuity and ability have been displayed in the most brilliant way during these investigations. Perhaps I may venture the suggestion that first, other intermediate temporary elements are formed, and that the energy liberated at this transmutation appears first in the shape of *new*, still imperfectly known forms. It is most likely that such forms are originated during the decay of the enormously concentrated energy of radium; at the same time it is probable that we have not yet the means of fixing these forms and so preventing their changing into other more common forms. We should remember that, for example, the conservation of electric energy at a pressure of some thousand volts during some months or years is by no means an easy thing, and I have great doubt if it is possible at all.

But here I must conclude, for I have ventured to intrude on a field where I have not secured my own right of entry by personal work. I see among my audience men who are possessed of an incomparably more minute and comprehensive knowledge of these new realms of science than I. I must ask you, therefore, to take these suggestions in the same spirit as that in which Faraday took his own speculations. They are questions put to nature. If she says Yes, then we may follow the same path a little further. If she says No—well, then we must try another path.

1 Compare Soddy, "The Wilde Lecture," *Mem.* and *Proc.* Manchester Lit. and Phil. Soc., 1904. I am very glad to find that I am in close agreement (except in so far as there is a difference in his accepting the atomistic, while I hold by the energetic point of view) with this most zealous and fortunate worker; indeed, the above statements were written and printed before I saw Mr. Soddy's lecture.

A SMITHSONIAN MAGAZINE OF SCIENCE.

TO provide a medium for the early publication of the results of researches conducted under the auspices of the Smithsonian Institution, and especially for the publication of reports of a preliminary nature, a quarterly issue of the *Smithsonian Miscellaneous Collections* has been commenced. This new periodical has the form of an attractive magazine, and contains papers on a variety of subjects of scientific interest, most of them beautifully illustrated.

The number opens with a description of seventy new Malayan mammals, by Mr. Gerrit S. Miller, jun., based on collections made and presented to the U.S. National Museum by Dr. W. L. Abbott. Mr. C. G. Abbot presents the results of recent studies of the solar constant of radiation, conducted at the Astrophysical Observatory of the Smithsonian Institution, under the direction of Dr. S. P. Langley. Another paper by Mr. Abbot describes the new cœlostat and horizontal telescope of the Astrophysical Observatory, in which are given the results obtained with a device designed by Dr. Langley for the purpose of "churning" a column of air traversed by a solar beam, with the view of reducing the "boiling" or confusion of all parts of the solar image due to variability of the strata of air traversed. Dr. F. W. True presents some photographic illustrations of living finback whales from Newfoundland, these being the first photographs of living whales in American waters that have thus far been published. Brief descriptions of a skeleton of Hesperornis, and a new Plesiosaur, by Mr. Frederic A. Lucas, are given with plates, and Mr. W. H. Holmes illustrates and compares the designs on some remarkable shell ornaments from Kentucky and Mexico.

A noteworthy specimen of a Glacial pothole in the National Museum is described by Mr. George P. Merrill, who explains the method by which the specimen was procured. Some notes on the herons of the district of Columbia, by Mr. Paul Bartsch, who made a systematic survey of two heron colonies and conducted experiments with the view of solving some of the problems of bird life, are of special interest. Dr. J. Walter Fewkes gives a preliminary report on an archæological trip to the West Indies

in 1903, describing particularly the remarkable objects of stone, bone, shell, wood, and pottery which he collected during the trip, and giving an insight into their various uses. Dr. C. M. Child, of Chicago University, describes the form-regulation in Cœlentera and Turbellaria, of which he made a special study during his occupancy of the Smithsonian table at the Naples Zoological Station, and Dr. Carl H. Eigenmann introduces some new genera of South American fresh-water fishes, and new names for some old genera. Of timely interest is the account of Korean headdresses in the U.S. National Museum by the late Mr. F. H. Jenings, in which are described and illustrated twenty-four varieties of Korean hats and other headgear, including headband buttons and hatpins for topknots.

A brief history of the Hodgkins Fund of the Smithsonian Institution, and of what has been accomplished with its income toward "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man," bears the name of Helen Waldo Burnside, and is accompanied with an illustration of the beautiful Hodgkins medal. Mr. A. B. Baker gives an account of a notable success in the breeding of black bears, which is of special interest to those having charge of animal collections. In a contribution on Chinese medicine, Dr. James M. Flint briefly explains the origin of medicine and the theory of disease in the Celestial Empire. The last of the series of articles consists of notes on the rocks of Nugsuaks Peninsula and its environs, Greenland, by Mr. W. C. Phalen, the remaining pages of the magazine being occupied by brief descriptions of various activities of the institution and their results.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is a copy of the speech delivered on April 28 by the Public Orator, Dr. Sandys, in presenting Prof. Ostwald, of Leipzig, for the degree of Doctor in Science *honoris causa*.

Viri et rerum naturae in scientiis excolendis et scientiarum illarum in terminis propagandis prospere occupati, non unius tantum populi intra fines angustos cohibentur, sed orbis terrarum totius inter cives merito numerantur. Nuper apud Londinienses Faradaii nostri memoriam oratione luculenta prosecutus est vir scientiarum laude illustris, qui a Germanis olim oriundus, Germanorum ultra terminum orientalem Russorum in imperio natus et professoris officio functus, postea in ipsam Germaniam atque adeo ad universitatem insignem Lipsiensem vocatus, in scriptis suis omnibus Germanorum gravitatem cum Francogallorum stilo lucido consociavit. Idem ne Europae quidem terminis contentus est, auctumno proximo (nisi fallor), velut alter Mercurius, Atlantis nepos facundus, etiam aequor Atlanticum transiturus. Quanta diligentia, memoria quam tenaci, ingenio quam multiplici praeditus, scientiae chemicae et scientiae physicae confinia quam diu quam feliciter lustravit, a collegis magnis sine ulla invidia peregre laudatus, a discipulis plurimis in omni orbis terrarum regione dilectus. Quot opera, inter sese quam varia, scientiae suae explicandae destinavit; idem etiam aliorum labores in Actis a sese tam diu editis quam diligenter in unum collegit, collectos in ordinem quam perspicuum redegit. Nemo mirabitur Actorum illorum librum prope quinquagesimum viri tanti in honorem nuper esse dedicatum, qui abhinc annos fere quinquaginta natus, vitae suae iam per partem dimidiam doctoris nomine decoratus est. Virum talem ad litora nostra honoris causa nuper vocatum, etiam nostro doctoris titulo libenter ornamus.

A COMBINED examination of non-resident candidates for open scholarships, exhibitions, &c., will be held at Trinity College, Clare College, Trinity Hall, Peterhouse, and Sidney Sussex College, Cambridge, beginning on Tuesday, December 6. Candidates will be examined at each college at the same time and by the same papers. Forms of application for admission to the examination may be obtained from any of the Tutors of Trinity College, the Senior Tutor of Clare College, the Master of Trinity Hall, the Senior Tutor of Peterhouse, or the Master of Sidney Sussex College. Entries should be made not later than November 18. Papers will be set in classics, mathematics, natural sciences, moral sciences and history. In mathematics and science the range of subjects included in the examination will be as follows:—*Mathematics.*—Arithmetic, geometry, algebra, trigonometry, elementary statics and dynamics, conic sections treated both geometrically and analytically, and the elements of the differential calculus. *Natural Sciences.*—Physics, chemistry, zoology, botany, physiology, and geology. Candidates for an emolument at Clare College may also offer elementary biology as a subject. Of these subjects no candidate may offer more than three. In making awards, excellence in one subject or in two subjects will be taken especially into account. There will also be (1) a paper of general questions in natural sciences which must be taken by all candidates who offer natural sciences, and (2) an optional paper in mathematics suitable for candidates who offer physics as one of their subjects.

THE Education Bill for Scotland was read a second time in the House of Commons on Monday by a majority of fifty-seven.

A LIST of the courses of lectures proposed for the summer term in the various German-speaking universities and technical schools is given in the *Physikalische Zeitschrift* for April 15.

THE foundation-stone of an extension of the Durham College of Science, Newcastle-on-Tyne, was laid on Monday by Mr. T. G. Gibson. The cost of the new buildings has been provided by a fund of 50,000*l.*, raised to commemorate the life of the first Lord Armstrong, whose name the college will henceforward bear.

A COURSE of ten advanced lectures on the "Tracts of the Brain," by Dr. W. Page May, was commenced yesterday at University College, and will be continued on Wednesdays at 5 p.m. The lectures are open without fee to all internal students of the university.

THE following appointments are announced:—Dr. Friedrich Engel, of Leipzig, professor of mathematics in Greifswald; Dr. J. Schubert, of Eberswald, professor of physics, meteorology and geodesy; Dr. K. Hopfgartner, of Innsbruck, professor of chemistry; Dr. K. Schaum, of Marburg, extraordinary professor of physical chemistry; Prof. Paul Behrend, of Hohenheim, professor of organic chemistry; Prof. Lorenz, of Göttingen, ordinary professor of mechanics; and Prof. Roessler, of Charlottenburg, professor of electrotechnics—the last three at the Danzig Technical School; Dr. A. Hagenbach, professor of physics at Aachen; Prof. Moersch, professor of engineering at Zurich; Dr. Wedekind, of Tubingen, and Dr. Otto Dimroth, extraordinary professors.

REPLYING to a question in the House of Commons on April 27, Mr. Brodrick said that papers would shortly be laid on the table relating to the subject of the further maintenance of Coopers Hill College, including the report of the committee which sat last year. In consequence of the strong recommendations of that committee and the evidence brought before them, that efficient candidates for the Public Works Department in India can be provided by other engineering colleges at a less cost to the candidates and to the Indian Government, it has been decided to close the college. No decision, however, has yet been arrived at as to the date of closing, and all possible consideration will be shown to those concerned.

IN his presidential address at the recent annual general meeting of the Institute of Chemistry, Mr. David Howard reviewed the work of the council of the institute during the past year. Among other matters of interest he referred to the work of a special committee appointed to consider the advisability of instituting examinations for technical chemists. Mr. Howard said the most common difficulty at present is how to bridge over the gap between the scientific training and the practical work of the technical chemist. "What the chemist has to learn is to think in tons, not in grams." A large number of well known manufacturers consulted by the committee, while agreeing as to the value of a sound training in chemistry and physics, were emphatic that they did not want chemists trained or examined in the special technology of particular industries. The scheme drawn up by the committee is, as far as